**CRF 8G** (Revised Sep 15)

| RGC Reference | HKUST6/CRF/12R |
|---|---|
| *please insert ref. above* | |

# The Research Grants Council of Hong Kong
# Collaborative Research Fund Group Research Projects
# Completion Report

*(for completed projects only)*

## Part A: The Project and Investigator(s)

### 1. Project Title

Green Slope Engineering: Bioengineered, Live Cover Systems for Man-made Fill Slopes and Landfill Capillary Barriers in Hong Kong

### 2. Investigator(s) and Academic Department/Units Involved *(please highlight approved changes in the composition of the project team and quote the date when RGC granted approval of such changes)*

| | Name | Post | Unit/Department/Institution |
|---|---|---|---|
| Project Coordinator | Professor Ng, Charles Wang-Wai | Chair Professor | Civil & Environmental Engineering /HKUST |
| Co-Investigator | Professor Tham, Leslie George | Professor / Associate Dean of Engineering | Civil Engineering /HKU |
| Co-Investigator | Professor Wong, Ming Hung | Research Chair Professor | Department of Science and Environmental Studies/HKIEd |
| Co-Investigator | Professor Zhang, Limin | Professor/ Director of Geotechnical Centrifuge Facility | Civil & Environmental Engineering /HKUST |
| Co-Investigator | Professor Zhang, Qian | Professor & Director of Huawei-HKUST Innovation Lab | Department of Computer Sciences and Engineering/HKUST |
| Co-Investigator | Dr Pryor, Matthew | Assistant Professor/Head | Division of Landscape Architecture /HKU |
| Co-Investigator | Dr Chu, Lee Man | Associate Professor | School of Life Sciences /CUHK |
| Co-Investigator | Dr Wang, Yu Hsing | Associate Professor | Civil & Environmental Engineering /HKUST |
| Co-Investigator | Dr Hau, Billy Chi Hang | Assistant Professor | School of Biological Sciences/HKU |
| Co-Investigator | Dr Yan, Wai Man | Assistant Professor | Civil Engineering /HKU (moved to University of Auckland) |

## 3. Project Duration

| | Original | Revised | Date of RGC Approval *(must be quoted)* |
|---|---|---|---|
| Project Start Date | 30 June 2013 | n/a | |
| Project Completion Date | 29 June 2016 | | |
| Duration *(in month)* | 36 | | |
| Deadline for Submission of Completion Report | 29 June 2017 | | |

## Part B: The Final Report

### 5. Project Objectives

5.1 Objectives as per original application

1. *To investigate the suitability of selected native grass and woody species (using live poles) for improving the stability of bioengineered, live, unsaturated, cemented fill slopes and live landfill barriers under sub-tropical and tropical climates;*
2. *To advance novel non-destructive wave techniques and smart sensors to monitor variations of moisture in unsaturated man-made green fill slopes and landfills in response to different weather conditions;*
3. *To explore and improve our fundamental understanding of the influence of cementation, soil density and landfill gases on the growth of selected native species, the landscape and the ecology as a whole;*
4. *To develop new experimental methods such as soil columns, flume models and centrifuge modelling techniques to investigate gas breakthrough in proposed multi-layer, unsaturated soil capillary barrier and diversion length for landfill cover design;*
5. *To study, condition and optimize the analysis and design of a capillary barrier as an environmentally friendly, live, vegetated landfill capping;*
6. *To develop a reliability-based preliminary guideline for the design, construction and management of live cover systems that are self-regenerative and sustainable for both man-made fill slopes and landfills;*
7. *To export the novel technology developed in this project overseas.*

5.2 Revised objectives

Date of approval from the RGC: n/a

Reasons for the change: _____

_____

## 6. Research Outcome

6.1 Major findings and research outcome
*(maximum 1 page; please make reference to Part C where necessary)*

The project has led to significant new developments such as the design and invention of a new three-layer landfill cover system for preventing both water infiltration into a landfill and gas emission from the landfill under all weather conditions (U.S. Patent 9101968B2; Chinese Patent CN103572785B). This new landfill cover system is environmentally friendly as vegetation and recycled construction waste are an integral part of its design. Comparing with traditional designs, it is novel and vital that no geomembrane is needed as the geomembranes are susceptible to interface instability and they are also highly prone to tears and punctures. Additional new development includes a novel artificial root model system that can simulate both the mechanical and hydrological effects of roots having various architectures on induced soil suction and slope stability in the centrifuge. A new non-destructive testing techniques and sensor for field monitoring such as OhmMapper and Smart Soil Particles were also developed. World class facilities were also established to study in depth the atmosphere-plant-soil interactions and the new three-layer landfill cover system. These facilities are: (1) A Temperature and humidity controlled room in the HKUST Geotechnical laboratory; (2) HKUST Eco-park with a 0.4 m high flat ground of 2 different degree of compactions (i.e., 80 and 100%) and a 2m high embankment with 2 different slope angles (i.e., 22° and 33°); (3) One-dimensional soil columns to study water infiltration, gas emission, gas breakthrough, methane oxidation and vegetation interaction of the three-layer landfill cover system; (4) Three large flume model box (3m x 1.5m x 1.0m) that are heavily instrumented to monitor pore-water pressure, volumetric water content, surface runoff, lateral drainage, infiltration rate and percolation; and (5) Full-scale field trial at the Shenzhen Xiaping landfill to validate the new three-layer landfill cover system under natural and extreme climatic conditions. Lastly, a design guideline for a green three-layer capillary barrier landfill cover system is completed (Appendix A). Based on these new developments, the following new theory and scientific contributions were discovered: (1) A new constitutive model to estimate the water retention ability of vegetated soil; (2) A new constitutive model to simulate conjunctive surface and subsurface transient flow considering different root architectures; (3) A new analytical model to calculate soil suction induced by different root architectures thereby to predict Factor of Safety (FOS) of vegetated soil slopes; (4) New fully coupled model for water-gas-heat coupled reactive transport in unsaturated soil with methane oxidation; (5) Ecological performance assessment of the South East New Territories (SENT) Landfill in Hong Kong (2000-2012) considering plant, animal and bacterial communities;

(6) Plant species selection recommendation for restoring sanitary landfills; (7) Explored the feasibility of biochar application on a landfill final cover for balancing ecology and shallow slope stability; (8) Tested and verified the applicability of sustainable materials (i.e., construction waste, ground granulated blast-furnace slag) as substitute materials for the three-layer landfill cover system. (9) Determined the biodiversity recovery of cemented soil slopes; (10) Verified the growth performance of trees in cemented soil and enable engineers to select the appropriate plant species for the design and construction of vegetated cemented slopes; (11) Improved understanding on surface erosion of vegetated cemented soil slopes; (12) Stability of trees under lateral pulling; and (13) Stability of vegetated slopes considering uncertainties in root distribution and transpiration induced suction. Finally, all of the new developments, theories and scientific contributions have resulted in 88 published journal papers and 27 conference papers which are listed in Part C. In addition, several more manuscripts are provisionally accepted or still under review. A total of 10 M. Phil and 20 Ph. D students have been trained and graduated with support of the project.

6.2 Potential for further development of the research and the proposed course of action *(maximum half a page)*

Wind erosion is a serious environmental problem across the globe. Based on the improved understanding of atmosphere-plant-soil interaction, it will be very meaningful to also study the mechanisms on how plants protect the soil against wind erosion. Wind tunnels have been used for several decades to study wind erosion processes and may be extended to incorporate plants. Also, contrary to prevailing assumptions, natural and engineered soils can exhibit low wettability. Despite research on the hydrological effects of soil water repellency, very little is known on the influence of water repellency on plant behaviour. It is worthwhile and meaningful to understand the effects of soil water repellency on both slope stability and plant growth. Furthermore, investigating the effects of different soil amendments on increasing the extraction yield of Chinese medicinal plants can be carried out which may potentially lead to breakthrough on multi-disciplinary research.

6.3 Research collaboration achieved *(please give details on the achievement and its relevant impact)*

Close collaboration was needed in order to achieve the results presented above. The team met regularly over the entire grant period. For more details, please refer to a copy of minutes of the last two progress meeting in Appendix B and C. Collaboration among the different departments and institutions take advantage of complementary expertise and equipment available in the different institutions facilities. For example, under the collaboration between the Department of Civil and Environmental Engineering and the Department of Computer Science and Engineering, the novel sensor, Smart Soil Particle (SSPs), has been developed. Another example is the joint supervision of two Ph.D students by HKUST and HKIEd. One has successfully defended his Ph.D on May 2017 while the other one will graduate this coming August 2017.

Another example of the collaboration between HKUST and the HKIEd group is to study the 12-year ecological performance of the South East New Territories (SENT) landfill. The collaboration between engineering science and biological science is essential for the balance of ecological restoration and limit state design.

A research collaboration was also established with Zhejiang University under the leadership of Professor Yunmin Chen and Tony Liangtong Zhan. They are PIs of a 973 project. A meeting was

held on August 2014 to agree on the field trial using the new three-layer landfill cover system in a landfill site at Xiaping, Shenzhen. Representatives from Zhejiang University (ZU), Harbin Institute of Technology in Shenzhen (HITSZ) and Hohai University (HHU), HKUST and senior management from Xiaping Solid Waste (XSW) company attended the meeting and signed a collaborative agreement.

## 7. The Layman's Summary

*(describe in layman's language the nature, significance and value of the research project, in no more than 200 words)*

According to the Geotechnical Engineering Office, thousands of sub-standard man-made fill slopes are required to be upgraded urgently. However, current upgrading works do not consider the use of vegetation as an environmentally friendly option to stabilize shallow soil slopes. The findings from this project enable engineers to properly select which plant species can be used to stabilize cemented soil slopes. Also, current landfill cover design does not consider the use of vegetation for minimizing both rainfall infiltration and gas emission. A novel, durable and environmentally friendly self-regenerating live landfill cover system is thus developed for future covers. This new three-layer landfill cover system is environmentally friendly as vegetation and recycled construction waste are used as an integral part of its design. The fundamental principle of this new cover is to make use of unsaturated hydraulic characteristics of different types of construction wastes and soils. In addition, the new cover is self-regenerative, durable and almost maintenance free. No geomembrane is needed to eliminate interface instability in traditional cover systems. A design guideline for the design, construction and management of this new landfill cover system is also established.

## Part C: Research Output

## 8. Peer-reviewed journal publication(s) arising directly from this research project

*(Please attach a copy of the publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.)*

| The Latest Status of Publications | | | | Author(s) *(denote the corresponding author with an asterisk*)* | Title and Journal/Book *(with the volume, pages and other necessary publishing details specified)* | Submitted to RGC *(indicate the year ending of the relevant progress report)* | Attached to this report *(Yes or No)* | Acknowledged the support of RGC *(Yes or No)* | Accessible from the institutional repository *(Yes or No)* |
|---|---|---|---|---|---|---|---|---|---|
| Year of publication | Year of Acceptance (For paper accepted but not yet published) | Under Review | Under Preparation (optional) | | | | | | |
| 2017 | | | | Chen, X.W., Wong J.T.F., Leung, A.O.W., Ng, C.W.W.*, Wong, M.H.* | Comparison of plant and bacterial communities between a subtropical landfill topsoil 15 years after restoration and a natural area, *Waste Management*, Vol. 63, pp. 49-57. | 2017 | Yes | Yes | Yes |

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|---|---|---|---|---|---|---|---|---|---|
| 2016 | | | | Chen, X.W., Wong, J.T.F., Mo, W.Y., Man, Y.B., Ng, C.W.W.*, Wong, M.H.* | Ecological performance of the restored South East New Territories (SENT) landfill in Hong Kong (2000-2012), *Land Degradation & Development,* Vol. 27, Issue 6, pp. 1664-1676. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Chen, Y., Lin, P., Zhang, Q.* | LOTUS: Location-aware online truthful double auction for dynamic spectrum access, *IEEE Transactions on Wireless Communications,* Vol. 14, Issue 2, pp. 1092-1099. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Chen, Y., Wu, K., Zhang, Q.* | From QoS to QoE: A tutorial on video quality assessment, *IEEE Communication Surveys & Tutorials,* Vol. 17, Issue 2, pp. 1126-1165. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Chen, Y.*, Chen, Q., Zhang, F., Zhang, Q., Wu, K., Huang, R., Zhou, L. | Understanding viewer engagement of video services in Wi-Fi network, *Computer Networks,* Vol. 91, pp. 101-116. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Chen, Y.*, Duan, L., Huang, J., Zhang, Q. | Balancing income and user utility in spectrum allocation, IEEE Transactions on Mobile Computing, Vol. 14, Issue 12, pp. 2460-2473. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Coo, J.L.*, So, P.S.Z., Ng, C.W.W. | Effect of nanoparticles on the shrinkage properties of clay, *Engineering Geology,* Vol. 213, pp. 84-88. | 2017 | Yes | Yes | Yes |
| 2017 | | | | Feng, S., Leung, A.K., Ng, C.W.W., Liu, H.W.* | Theoretical analysis of coupled effects of microbe and root architecture on methane oxidation in vegetated landfill covers, *Science of the Total Environment,* Vol. 599-600, pp. 1954-1964. | 2017 | Yes | Yes | No |

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|---|---|---|---|---|---|---|---|---|---|
| 2017 | | | | Feng, S., Ng, C.W.W., Leung, A.K., Liu, H.W.* | Numerical modelling of methane oxidation efficiency and coupled water-gas-heat reactive transfer in a sloping landfill cover. In Press, Corrected Proof. *Waste Management.* Doi: 10.1016/j.wasman.2017.04.042. | 2017 | Yes | Yes | No |
| 2015 | | | | Feng, X., Lin, P., Zhang, Q.* | FlexAuc: serving dynamic demands in a spectrum trading market with flexible auction, *IEEE Transactions on Wireless Communications,* Vol. 14, Issue 2, pp. 821-830. | 2014 but not the final version | Yes | Yes | Yes |
| 2014 | | | | Feng, X., Zhang, J., Zhang, Q.* | A hybrid pricing framework for TV white space database, *IEEE Transactions on Wireless Communications,* Vol. 13, Issue 5, pp. 2626-2635. | 2014 | No | Yes | Yes |
| 2017 | | | | Gao L., Zhang, L.M.*, Chen, H.X. | Likely scenarios of natural terrain shallow slope failures on Hong Kong island under extreme storms, *Natural Hazards Review*, Vol. 18, Issue 1. Doi: 10.1061/(ASCE)NH.1527-6996.0000207. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Gao, Y., Wang, Y.H.* | Experimental characterization of deformation, K0, stiffness, and contact force distributions of sand during secondary compression and rebound, *Canadian Geotechnical Journal*, Vol. 53, Issue 5, pp. 889-898. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Garg, A.*, Ng, C.W.W. | Investigation of soil density effect on suction induced due to root water uptake by *Schefflera heptaphylla*, *Journal of Plant Nutrition and Soil Science,* | 2014 but not the final version | Yes | Yes | Yes |

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|---|---|---|---|---|---|---|---|---|---|
| | | | | | Vol. 178, Issue 4, pp. 586-591. | | | | |
| 2015 | | | | Garg, A.*, Coo, J.L., Ng, C.W.W. | Field study on influences of root characteristics on suction distributions in slopes vegetated with *Cynodon dactylon* and *Schefflera heptaphylla*, *Earth Surface Processes and Landforms,* Vol. 40, Issue 12, pp. 1631-1643. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Garg, A.*, Leung, A.K., Ng, C.W.W. | Comparisons of suction induced by evapotranspiration and transpiration of *S. heptaphylla*, *Canadian Geotechnical Journal*, Vol. 52, Issue 12, pp. 2149-2155. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Garg, A.*, Leung, A.K., Ng, C.W.W. | Transpiration reduction and root distribution functions for a non-crop species *Schefflera heptaphylla*, *Catena*, Vol. 135, pp. 78-82. | 2014 but not the final version | Yes | Yes | Yes |
| | | | 2017 | Hau, B.C.H.*, Leung, F.T.Y., Lo, P.L. | Ecological restoration on man-made slopes in Hong Kong | 2017 | No | Yes | No |
| 2017 | | | | Hazra, B., Garg, A.*, Gadi, V., Ng, C.W.W., Das, G.K. | Probabilistic analysis of suction in homogeneously vegetated soils, *Catena*, Vol. 149, pp. 394-401. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Huang, Q.*, Gui, Y., Wu, F., Chen, G., Zhang, Q. | A general-privacy-preserving auction mechanism for secondary spectrum markets, IEEE/ACM Transactions on Networking, Vol. 24, Issue 3, pp. 1881-1893. | 2017 | Yes | Yes | Yes |
| | | | 2017 | Hui, L.C., Chu, L.M.* | Transpiration potential of tree species for use in live cover in subtropical regions | 2017 | No | Yes | No |

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|---|---|---|---|---|---|---|---|---|---|
| 2014 | | | | Kamchoom, V.*, Leung, A.K., Ng. C.W.W. | Effects of root geometry and transpiration on pull-out resistance, *Géotechnique Letters*, Vol. 4, Issue 4, pp. 330-336. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Leung, A.K.*, Coo, J.L., Ng, C.W.W., Chen, R. | New transient method for determining soil hydraulic conductivity function, *Canadian Geotechnical Journal*. Vol. 53, Issue 8, pp. 1332-1345. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Leung, A.K.*, Garg, A., Coo, J.L., Ng, C.W.W, Hau, B.C.H. | Effects of the roots of *Cynodon dactylon* and *Schefflera heptaphylla* on water infiltration rate and soil hydraulic conductivity, *Hydrological Processes*, Vol. 29, Issue 15, pp. 3342-3354. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Leung, A.K., Kamchoom, V.*, Ng, C.W.W. | Influences of root-induced soil suction and root geometry on slope stability: a centrifuge study, *Canadian Geotechnical Journal*, Vol. 54, Issue 3, pp. 291-303. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Leung, A.K.*, Ng, C. W. W | Field investigation of deformation characteristics and stress mobilisation in a soil slope, *Landslides*, Vol. 13, Issue 2, pp. 229-240. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Leung, A.K.*, Garg, A., Ng, C.W.W. | Effects of plant roots on soil-water retention and induced suction in vegetated soil, *Engineering Geology*, Vol. 193, pp. 183-197. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Leung, F.T.Y., Yan, W.M.*, Hau, B.C.H., Tham, L.G. | Root systems of native shrubs and trees in Hong Kong and their effects on enhancing slope stability. *Catena*, Vol. 125, pp. 102-110. | 2014 but not the final version | Yes | Yes | No |

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|---|---|---|---|---|---|---|---|---|---|
| | | 2017 | | Leung, F.T.Y.*, Yan, W.M., Tham, L.G., Hau, B.C.H. | The mechanical strength of four native tree and shrub species for ecological rehabilitation of roadside slopes in Hong Kong. Submitted to *Journal of Tropical Forest Science* | 2017 | No | Yes | Yes |
| 2016 | | | | Li, X.Y., Zhang, L.M.*, Li, J.H. | Using conditioned random field to characterize the variability of geologic profiles, *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 142, Issue 4. Doi: 10.1061/(ASCE)GT. 1943-5606.0001428. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Liu, H.W., Feng, S.*, Ng, C.W.W. | Analytical analysis of hydraulic effect of vegetation on shallow slope stability with different root architectures, *Computers and Geotechnics*, Vol. 80, pp. 115-120. | 2017 | Yes | Yes | Yes |
| | | | 2017 | Lo, W.F., Pang, C.C.*, Lo, P.L., Yan, W.M., Hau, B.C.H. | Vegetation performance on slopes using artificially cemented soil for stabilization | 2017 | No | Yes | No |
| 2015 | | | | Ng, C.W.W., Coo, J.L.* | Hydraulic conductivity of clay mixed with nanomaterials, *Canadian Geotechnical Journal,* Vol. 52, Issue 6, pp. 808-811. | 2014 but not the final version | Yes | Yes | Yes |
| 2014 | | | | Ng, C.W.W., Zhou, C.* | Cyclic behaviour of an unsaturated silt at various suctions and temperatures, *Geotechnique*, Vol. 64, No. 9, pp. 709-720. | 2014 | No | Yes | Yes |
| 2014 | | | | Ng, C.W.W., Leung, A.K.*, Kamchoom, V., Garg, A. | A novel root system for simulating transpiration-induced soil suction in centrifuge, *Geotechnical Testing Journal,* Vol. 37, No. 5, pp. 1–15. | 2014 | No | Yes | Yes |

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|---|---|---|---|---|---|---|---|---|---|
| 2014 | | | | Ng, C.W.W., Yu, R. | A novel technique to model water uptake by plants in geotechnical centrifuge, *Géotechnique Letters.* Vol. 4, Issue 4, pp. 244-249. | 2014 | No | Yes | Yes |
| 2015 | | | | Ng, C.W.W., Zhou, C.*, Leung, A.K. | Comparisons of different suction control techniques by water retention curves: Theoretical and experimental studies, *Vadose Zone Journal*, Vol. 14, Issue 9. Doi: 10.2136/vzj2015.01.0006. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Ng, C.W.W., Coo, J.L., Chen, Z.K., Chen, R.* | Water infiltration into a new three-layer landfill cover system, *Journal of Environmental Engineering, ASCE,* Vol.142, Issue 5. Doi: 10.1061/(ASCE)EE.1943-7870.0001074. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Ng, C.W.W., Feng, S.*, Liu, H.W. | A fully coupled model for water-gas-heat reactive transport with methane oxidation in landfill covers, *Science of the Total Environment,* Vol. 508, pp. 307-319. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Ng, C.W.W., Garg, A.*, Leung, A.K., Hau, B.C.H. | Relationship between leaf and root area indices and soil suction induced during drying-wetting cycles, *Ecological Engineering*, Vol. 91, pp. 113-118. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Ng, C.W.W., Liu, H.W.*, Feng, S. | Analytical solutions for calculating pore water pressure in an infinite unsaturated slope with different root architectures, *Canadian Geotechnical Journal*, Vol. 52, Issue 12, pp. 1981-1992. | 2014 but not the final version | Yes | Yes | Yes |

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|---|---|---|---|---|---|---|---|---|---|
| 2015 | | | | Ng, C.W.W., Liu, J., Chen, R.*, Xu, J. | Physical and Numerical Modeling of an Inclined Three-layer (silt/gravelly sand/clay) Capillary Barrier Cover System under Extreme Rainfall, *Waste Management,* Vol. 38, pp. 210-221. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Ng, C.W.W., Kamchoom, V.*, Leung, A. K. | Centrifuge modelling of the effects of root geometry on transpiration-induced suction and stability of vegetated slopes, *Landslides*, Vol. 13, Issue 5, pp. 925-938. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Ng, C.W.W., Chen, Z.K., Coo, J.L., Chen, R.*, Zhou, C. | Gas breakthrough and emission through unsaturated compacted clay in landfill final cover, *Waste Management,* Vol. 44, pp. 155-163. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Ng, C.W.W., Liu, J., Chen, R.*, Coo, J.L. | Numerical parametric study of an alternative three-layer capillary barrier cover system, *Environmental Earth Sciences,* Vol. 74, Issue 5, pp. 4419-4429. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Ng, C.W.W., Liu, J., Chen, R.* | Numerical investigation on gas emission from three landfill soil covers under dry weather conditions, *Vadose Zone Journal,* Vol. 14, Issue 8. Doi: 10.2136/vzj2014.12.0180. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Ng, C.W.W., Ni, J.J.*, Leung, A.K., Wang, Z.J. | A new and simple water retention model for root-permeated soils, *Géotechnique Letters*, Vol. 6, Issue 1, pp. 106-111. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Ng, C.W.W., Ni, J.J.*, Leung, A.K., Zhou, C., Wang, Z.J. | Effects of planting density on tree growth and induced soil suction, *Géotechnique,* Vol. 66, Issue 9, pp. 711-724. | 2017 | Yes | Yes | Yes |

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| 2016 | | | | Ng, C.W.W., Leung, A.K.*, Yu, R., Kamchoom, V. | Hydrological effects of live poles on transient seepage in an unsaturated soil slope: centrifuge and numerical study, *Journal of Geotechnical and Geoenvironmental Engineering, ASCE,* Vol. 143, Issue 3. Doi: 10.1061/(ASCE)GT. 1943-5606.0001616. | 2017 | Yes | Yes | Yes |
| | | 2017 | | Ng, C.W.W., Tasnim, R.*, Coo, J.L. | Effects of atmospheric $CO_2$ concentration on plant characteristics and plant induced soil suction, *Géotechnique* | 2017 | Yes | Yes | No |
| 2016 | | | | Ng, C.W.W., Xie, M.*, Leung, A.K. | Removal of hydrogen sulfide using soil amended with ground granulated blast furnace slag, *Journal of Environmental Engineering, ASCE,* Vol. 143, Issue 7. Doi: 10.1061/(ASCE)EE. 1943-7870.0001206. | 2017 | Yes | Yes | Yes |
| 2014 | | | | Niu, Q., Wang, Y.H.*, Zhao, K | Evaluation of the capacity coupled resistivity (line antenna) method for the characterization of vadose zone dynamics, *Journal of Applied Geophysics,* Vol. 106, pp. 119-127 | 2014 | No | Yes | Yes |
| 2016 | | | | Ni, J.J.*, Leung, A.K., Ng, C.W.W., So, P.S. | Investigation of plant growth and transpiration-induced matric suction under mixed grass-tree conditions, *Canadian Geotechnical Journal*, Vol. 54, Issue 4, pp. 561-573. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Niu, Q., Zhao, K., Wang, Y.H.*, Wu, Y. | Examining the influence of vegetation on slope hydrology in Hong Kong using the capacitive resistivity technique, *Journal of Applied Geophysics,* | 2014 but not the final version | Yes | Yes | Yes |

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|---|---|---|---|---|---|---|---|---|---|
| | | | | | Vol. 129, pp. 148-157. | | | | |
| 2015 | | | | Niu, Q., Fratta, D., Wang, Y. H.* | The use of electrical conductivity measurements in the prediction of hydraulic conductivity of unsaturated soils, *Journal of Hydrology*, Vol. 522, pp. 475-487. | 2014 but not the final version | Yes | Yes | Yes |
| | | 2017 | | Pang, C.C.*, Lo, W.F., Yan, W.M., Hau, B.C.H. | Plant community composition on landfill sites after multiple years of ecological restoration. Submitted to *Urban Forestry and Urban Greening* | 2017 | No | Yes | No |
| | 2017 | | | Shao, W.*, Ni, J.J., Leung, A.K., Su, Y., Ng, C.W.W. | Analysis of plant root-induced preferential flow and pore water pressure variation by a dual-permeability model. Accepted on 4 May. *Canadian Geotechnical Journal.* | 2017 | Yes | Yes | No |
| 2016 | | | | Shen, P., Zhang, L.M.*, Zhu, H. | Rainfall infiltration in a landslide soil deposit: Importance of inverse particle segregation, *Engineering Geology*, Vol. 205, pp. 116-132. | 2017 | Yes | Yes | Yes |
| 2017 | | | | Shen, P., Zhang, L.M.*, Chen, H.X., Gao, L. | Role of vegetation restoration in mitigating hillslope erosion and debris flows, *Engineering Geology*, Vol. 216, pp. 122-133. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Sumit, J., Wang, Y.H.*, Fredlund, D.G. | Non-contact sensing system to measure specimen volume during shrinkage test, *Geotechnical Testing Journal*, Vol. 38, Issue 6, pp. 936-949. | 2017 | Yes | Yes | Yes |
| 2014 | | | | Wang, W., Liao, Q., Zhang, Q.* | COD: A cooperative Cell Outage Detection architecture for self-organizing femtocell networks, *IEEE Transactions on Wireless* | 2014 but not the final version | Yes | Yes | Yes |

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|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Communications,* Vol. 13, Issue 11, pp. 6007-6014. | | | | |
| 2014 | | | | Wang, W., Zhang, Q.* | Local cooperation architecture for self-healing femtocell networks, *IEEE Wireless Communications* Magazine, Vol. 21, Issue 2, pp. 42-49. | 2014 | No | Yes | Yes |
| 2015 | | | | Wang, W., Yang, L., Chen, Y., Zhang, Q.* | A privacy-aware framework for targeted advertising, *Computer Networks,* Vol. 79, pp. 17-29. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Wang, W., Zhang Q.* | Privacy-preserving collaborative spectrum sensing with multiple service providers, *IEEE Transactions on Wireless Communications,* Vol. 14, Issue 2, pp. 1011-1019. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Wang, Y.H.*, Gao, Y., Ooi, G.L. | Experimental characterizations of an aging mechanism of sands, *Journal of Geotechnical and Geoenvironmental Engineering, ASCE,* Vol. 142, Issue 2. Doi: 10.1061/(ASCE)GT. 1943-5606.0001413. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Wang, W., Zhang, Q.* | Toward long-term quality of protection in mobile networks: A context-aware perspective, *IEEE Transactions on Wireless Communications,* Vol. 22, Issue 4, pp. 34-40. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Wang, W.*, Chen, L., Zhang, Q. | Outsourcing high-dimensional healthcare data to cloud with personalized privacy preservation, *Computer Networks,* Vol. 88, pp. 136-148. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Wang, W.*, Yang, L., Zhang, Q. | Privacy preservation in location-based advertising: A contract-based approach, *Computer* | 2017 | Yes | Yes | Yes |

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| | | | | | *Networks*, Vol. 93, pp. 213-224. | | | | |
| 2016 | | | | Wang, W.*, Chen, Y., Zhang, Q., Jiang, T. | A software-defined wireless networking enabled spectrum management architecture, *IEEE Communications Magazine*, Vol. 54, issue 1, pp. 33-39. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Wang, W.*, Chen, Y., Zhang, Q., Wu, K., Zhang, J. | Less transmissions, more throughput: Bringing carpool to public WLANs, *IEEE Transactions on Mobile Computing*, Vol. 15, Issue 5, pp. 1168-1181. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Wang, W.*, Zhang, Q. | Privacy preservation for context sensing on smartphone, IEEE/ACM Transactions on Networking, Vol. 24, Issue 6, pp. 3235-3247. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Wong, M.H.*, Chan, Y.S.G., Zhang, C.S., Ng, C.W.W. | Comparison of pioneer and native woodland species growing on top of an engineered landfill, Hong Kong: Restoration programme, *Land Degradation & Development,* Vol. 27, Issue 3, pp. 500-510. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Wong, J.T.F., Chen, X.W., Mo, W.Y., Man, Y.B., Ng, C.W.W*, Wong, M.H.* | Restoration of plant and animal communities in a sanitary landfill: A 10-year case study in Hong Kong, *Land Degradation & Development,* Vol. 27, Issue 3, pp. 490-499. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Wong, J.T.F., Chen, Z.K., Ng, C.W.W.*, Wong, M.H.* | Gas permeability of biochar-amended clay: potential alternative landfill final cover material, *Environmental Science and Pollution Research,* Vol. 23, Issue 8, pp. 7126-7131. | 2017 | Yes | Yes | Yes |

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|---|---|---|---|---|---|---|---|---|---|
| 2017 | | | | Wong, J.T.F., Chen, Z.K., Chen, X.W., Ng, C.W.W.*, Wong, M.H.* | Soil-water retention behavior of compacted biochar-amended clay: a novel landfill final cover material, *Journal of Soils and Sediments,* Vol. 17, Issue 3, pp. 590-598. | 2017 | Yes | Yes | Yes |
| 2017 | | | | Wu, Y., Wang, Y.H.*, Niu. Q. | Integrating the four-probe method and SWCC device to measure electrical resistivity anisotropy of unsaturated soil, *Geotechnical Testing Journal*, Vol. 40, Issue 4. Doi: 10.1520/GTJ20160160. | 2017 | Yes | Yes | Yes |
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| 2015 | | | | Yan, W.M.*, Zhang, G. | Soil-water characteristics of compacted sandy and cemented soils with and without vegetation, *Canadian Geotechnical Journal,* Vol. 52, Issue 9, pp. 1331-1344. | 2014 but not the final version | Yes | Yes | No |
| 2016 | | | | Yan, W.M.*, Zhang, L., Leung, F.T.Y., Yuen, K.V. | Prediction of the root anchorage of native young plants using Bayesian inference, *Urban Forestry and Urban Greening*, Vol. 19, pp. 237-252. | 2017 | Yes | Yes | No |
| 2016 | | | | Yang, Z.*, Zhang, Q. | Low-cost and accurate 3D road modeling using mobile phone, *IEEE Transactions on Mobile Computing*, Vol. 15, Issue 10, pp. 2494-2506. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Yeung, K.S.W., Yan, W.M.*, Hau, B.C.H | Performance of ground penetrating radar in root detection and its application in root diameter estimation under controlled conditions, *Science* | 2014 but not the final version | Yes | Yes | No |

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| | | | | | *China Earth Sciences*, Vol. 59, Issue 1, pp. 145-155. | | | | |
| | | | 2017 | Yeung, K.S.W., Yan, W.M.*, Hau, B.C.H | Small trees subjected to loading-unloading cycles of lateral pulling: I. Tree responses from field studies | 2017 | No | Yes | No |
| 2016 | | | | Yu, C.Y., Chow, J.K, Wang, Y.H.* | Pore-size changes and responses of kaolinite with different structures subject to consolidation and shearing, *Engineering Geology*, Vol. 202, pp. 122-131. | 2017 | Yes | Yes | Yes |
| 2016 | | | | Yuan, Q., Wang, Y.H.*, Tam, P.O., Li, X., Gao, Y. | Making a biaxial testing system with the aid of 3D printing technique to examine the kinetic behavior of particulate media, *Geotechnical Testing Journal*, Vol, 39, Issue 2, pp. 264-281. | 2017 | Yes | Yes | Yes |
| 2017 | | | | Yuan, Q., Wang, Y.H.*, Tam, P.O., Li, X., Gao, Y. | Experimental characterizations of contact movements in two-dimensional rod assembly subjected to direct shearing, *International Journal of Geomechanics, ASCE,* Vol. 17, Issue 1. Doi: 10.1061/(ASCE)GM. 1943-5622.0000685. | 2017 | Yes | Yes | Yes |
| | 2017 | | | Zhang, L.M.*, Ke, Y. | Optimal design of granular capillary barriers for minimizing rainfall infiltration and gas emission. Accepted. *Canadian Geotechnical Journal.* | 2017 | Yes | Yes | No |
| 2016 | | | | Zhang, Z., Wang, Y.H.* | DEM modelling of aging or creep in sand based on the effects of microfracturing of asperities and evolution of microstructural anisotropy during triaxial creep, *Acta Geotechnica*, Vol. 11, Issue 6, pp. | 2017 | Yes | Yes | Yes |

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| | | | | | 1303-1320. | | | | |
| 2014 | | | | Zhou, Y.F.*, Tham, L.G., Yan, W.M., Dai, F.C., Xu, L. | Laboratory study on soil behaviour in loess slope subjected to infiltration, *Engineering Geology,* Vol. 183, pp. 31-38. | 2014 | No | Yes | Yes |
| 2014 | | | | Zhou, C.*, Ng, C.W.W. | A new and simple stress-dependent water retention model for unsaturated soil, *Computers and Geotechnics*, Vol. 62, pp. 216-222. | 2014 | No | Yes | Yes |
| 2015 | | | | Zhou, C.*, Ng, C.W.W., Chen, R. | A bounding surface plasticity model for unsaturated soil at small strains, *International Journal for Numerical and Analytical Methods in Geomechanics.* Vol. 39, Issue 11, pp. 1141-1164. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Zhou, C.*, Ng, C.W.W. | Simulating the cyclic behaviour of unsaturated soil at various temperatures using a bounding surface model, *Géotechnique,* Vol. 66, Issue 4, pp. 344-350. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Zhou, C.* Ng, C.W.W. | A thermomechanical model for saturated soil at small and large strains, *Canadian Geotechnical Journal,* Vol. 52, Issue 8, pp. 1101-1110. | 2014 but not the final version | Yes | Yes | Yes |
| 2016 | | | | Zhou, C.*, Ng, C.W.W. | Effects of temperature and suction on plastic deformation of unsaturated silt under cyclic loads, *Journal of Materials in Civil Engineering,* ASCE, Vol. 28, Issue 12. Doi: 10.1061/(ASCE)MT. 1943-5533.0001685. | 2017 | Yes | Yes | Yes |
| 2015 | | | | Zhu, H., Zhang, L.M.* | Evaluating suction profile in a vegetated slope considering uncertainty in transpiration, *Computers and* | 2014 | No | Yes | Yes |

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| | | | | | *Geotechnics*, Vol. 63, pp. 112–120. | | | | |
| 2016 | | | | Zhu, H., Zhang, L.M.* | Field investigation of erosion resistance of common grass species for soil bioengineering in Hong Kong, *Acta Geotechnica*, Vol. 11, Issue 5, pp. 1047-1059. | 2014 but not the final version | Yes | Yes | Yes |
| 2015 | | | | Zhu, H., Griffiths, D.V., Fenton, G.A., Zhang, L.M.* | Undrained failure mechanisms of slopes in random soil, *Engineering Geology*, Vol. 191, pp. 31-35. | 2014 but not the final version | Yes | Yes | Yes |
| 2017 | | | | Zhu, H., Zhang, L.M.*, Xiao, T., Li, X.Y. | Enhancement of slope stability by vegetation considering uncertainties in root distribution, *Computers and Geotechnics*, Vol. 85, pp. 84-89. | 2017 | Yes | Yes | Yes |

**9. Recognized international conference(s) in which paper(s) related to this research project was/were delivered** *(Please attach a copy of each conference abstract)*

| Month/Year/ Place | Title | Conference Name | Submitted to RGC *(indicate the year ending of the relevant progress report)* | Attached to this report *(Yes or No)* | Acknowledged the support of RGC *(Yes or No)* | Accessible from the institutional repository *(Yes or No)* |
|---|---|---|---|---|---|---|
| Sept/2013/ Paris | Experimental study of resilient modulus of unsaturated soil at different temperatures | The 18th International Conference on Soil Mechanics and Geotechnical Engineering (18th ICSMGE) | 2014 | Yes | Yes | Yes |
| April/2014/ VA, USA | LOTUS: Location-aware online truthful double auction for dynamic spectrum access | IEEE International Symposium on Dynamic Spectrum Access Networks (DYSPAN) | 2017 | Yes | Yes | Yes |
| May/2014/ Toronto, Canada | A stochastic game for privacy preserving context sensing on mobile phone | IEEE Conference on Computer Communications (INFOCOM) | 2017 | Yes | Yes | Yes |
| May/2014/ Toronto, Canada | Delay-throughput tradeoff with correlation mobility of Ad-Hoc networks | IEEE Conference on Computer Communications (INFOCOM) | 2017 | Yes | Yes | Yes |

**CRF 8G** (Revised Sep 15)

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|---|---|---|---|---|---|---|
| Oct/2014/ Chuncheon, Korea | Ecological monitoring of the restored SENT landfill in Hong Kong (2000-2012) | 2nd International Conference on Contaminated Land, Ecological Assessment and Remediation (CLEAR 2014) | 2014 | Yes | Yes | No |
| Oct/2014/ Chuncheon, Korea | Plant and animal community restoration in Hong Kong South East New Territories (SENT) landfill (2003-2012) | 2nd International Conference on Contaminated Land, Ecological Assessment and Remediation (CLEAR 2014) | 2014 | Yes | Yes | No |
| June/2014/ Delft, The Netherlands | Effects of spatial variability on unsaturated groundwater flow | 8th European Conference on Numerical Methods in Geotechnical Engineering (8th NUMGE) | 2014 | Yes | Yes | Yes |
| Oct./2014/ NC, USA | Wireless rate adaptation via smart pilot | IEEE 22nd International Conference on Network Protocols (ICNP) | 2017 | Yes | Yes | Yes |
| Nov./2015/ Fukuoka, Japan | Near real-time landslide monitoring with the smart soil particles | The 15th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering (15ARC) | 2017 | Yes | Yes | No |
| Dec./2015/ Hong Kong | The use of the capacitive resistivity method to study geo-environmental related problems | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | Yes |
| Dec./2015/ Hong Kong | A new alternative all-weather earthen landfill cover system | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | Yes |
| Dec./2015/ Hong Kong | Gas emission through unsaturated compacted silt and clay layers | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | No |
| Dec./2015/ Hong Kong | Effect of nanomaterial on the permeability of landfill compacted barriers | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | No |

**CRF 8G** (Revised Sep 15)

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| Dec./2015/ Hong Kong | Role of methane oxidation in coupled water-gas-heat reactive transport: Numerical simulation | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | Yes |
| Dec./2015/ Hong Kong | Hydrogen sulfide mitigation of nano-carbon-amended clay: Potential alternative landfill cover material | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | Yes |
| Dec./2015/ Hong Kong | Effects of biochar application on soil-water retention behaviour of compacted clay | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | No |
| Dec./2015/ Hong Kong | Remove hydrogen sulfide by ground granulated blast furnace slag (GGBS) amended soil | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | Yes |
| Dec./2015/ Hong Kong | Optimal design of granular landfill cover for minimizing rainfall infiltration and gas emission | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | No |
| Dec./2015/ Hong Kong | A preliminary study on the compressibility of saturated biochar-amended soil | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | No |
| Dec./2015/ Hong Kong | Root cohesion of the selected native species for slope upgrading in Hong Kong | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | No |
| Dec./2015/ Hong Kong | Effect of planting spacing on soil hydraulic properties in landfill cover | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | Yes |
| Dec./2015/ Hong Kong | Tree height effects on local root water uptake of vegetation as a geo-environmental technique | the 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) | 2017 | Yes | Yes | Yes |
| Dec./2015/ CA, USA | QoE-aware dynamic video rate adaptation | IEEE Global Communications Conference (GLOBECOM) | 2017 | Yes | Yes | Yes |

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|---|---|---|---|---|---|---|
| Sep./2016/ Queensland, Australia | A preliminary study on evaluating the performance of aged landfill covers using DC and CC resistivity methods | The 5th International Conference on Geotechnical and Geophysical Site Characterization (ISC) | 2017 | Yes | Yes | Yes |
| Sep./2016/ Paris | Feasibility study of a new unsaturated three-layer landfill cover system | 3rd European Conference on Unsaturated Soil (EUNSAT) | 2017 | Yes | Yes | Yes |
| Sep./2016/ Paris | Experimental study of gas breakthrough and emission in an unsaturated clay landfill cover | 3rd European Conference on Unsaturated Soil (EUNSAT) | 2017 | Yes | Yes | Yes |
| Nov./2016/ Taipei, Taiwan | A field investigation on the effects of biochar on soil aggregation in landfill final cover | 3rd International Conference on Contaminated Land, Ecological Assessment and Remediation (CLEAR 2016) | 2017 | Yes | Yes | Yes |

## 10. *Student(s) trained* (please attach a copy of the title page of the thesis)

| Name | Degree registered for | Date of registration | Date of thesis submission/ graduation |
|---|---|---|---|
| CHEN Xunwen | Ph.D | Sept. 2013 (HKUST) | May 2017 |
| CHEN Zhongkui, Bruce | Ph.D | Sept. 2012 (HKUST) | Aug. 2016 |
| CHOW Jun Kang | M.Phil | Sept. 2014 (HKUST) | Aug. 2016 |
| COO Jason Lim | Ph.D | Sept. 2012 (HKUST) | Jan. 2017 |
| FENG Song | Ph.D | Sept. 2012 (HKUST) | Aug. 2016 |
| Garg Ankit | Ph.D | Sept. 2010 (HKUST) | Jan. 2015 |
| HUI Ling Chui | M.Phil | Sept. 2013 (CUHK) | April 2017 |
| JAIN Sumit | M.Phil | Sept. 2013 (HKUST) | Aug. 2015 |
| KAMCHOOM Viroon | Ph.D | Sept. 2010 (HKUST) | Aug. 2015 |
| KE Yanqing | M. Phil | Aug. 2013 (HKUST) | Aug. 2015 |
| LEUNG, Tsz Yan Flora | Ph.D | Sept. 2010 (HKU) | Sept. 2014 |
| LIU Hongwei | Ph.D | Sept. 2013 (HKUST) | July 2017 (expected) |
| LO Wing Fung | Ph.D | Sept. 2013 (HKU) | Ongoing |
| NI Junjun | Ph.D | Sept. 2013 (HKUST) | May 2017 |
| NIU Qifei | Ph.D | Sept. 2010 (HKUST) | Jan. 2014 |
| SHEN Ping | Ph.D | Sept. 2014 (HKUST) | Ongoing |
| SO Pui San, Zac | M.Phil | Sept. 2015 (HKUST) | Ongoing |
| OOI Ghee Leng | Ph.D | Sept. 2012 (HKUST) | Aug. 2017 (expected) |
| TASNIM Rafa | M.Phil | Feb. 2016 (HKUST) | Ongoing |
| TAN Pin Siang | M.Phil | Sept. 2013 (HKUST) | Aug. 2015 |
| WANG Zijian, Thomas | Ph.D | Sept. 2013 (HKUST) | Aug. 2017 (expected) |
| WONG Tsz Fung, James | Ph.D | Sept. 2013 (HKUST) | Aug. 2017 (expected) |
| WU Yuxin | Ph.D | Sept. 2014 (HKUST) | Aug, 2018 (expected) |
| XIE Mengyao, Anny | M.Phil | Sept. 2014 (HKUST) | Dec. 2016 |
| YEUNG Shan Wing | Ph.D | Sept. 2012 (HKU) | April 2017 |
| YU Ruiwang | M.Phil | Sept. 2012 (HKUST) | Jan. 2015 |
| YUAN Quan | Ph.D | Sept. 2010 (HKUST) | Aug. 2016 |
| ZHANG Guanghui | M.Phil | Sept., 2012 (HKU) | Oct. 2014 |
| ZHOU Chao | Ph.D | Sept. 2009 (HKUST) | Aug. 2014 |
| ZHU Hong | Ph.D | Sept. 2010 (HKUST) | Aug. 2014 |

**11. Other impact** *(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, etc.)*

- USA patent publication no. US9101968B2 – Charles W.W. Ng, Jie Xu and Rui Chen "All-weather landfill soil cover system for preventing water infiltration and landfill gas emission" (Granted on 11 August 2015).
- USA provisional patent no. 62/177705 (PCT application is supported by the university) "Making a biaxial testing system with the aid of 3D printing technique to examine the kinetic behavior of particulate media"
- USA provisional patent no. 62/497046 "Integrating the four-probe method and SWCC device to measure electrical resistivity anisotropy of unsaturated soil"
- Chinese patent publication no. CN103572785B- 吴宏伟、徐洁和陈锐 "全天候防渗闭气的垃圾填埋土质覆盖系统、制法和用途" (Granted on 2 March 2016)
- Chinese patent publication no. CN103424535A- 余瑞旺、吴宏伟和乔劼 "用于土工离心机中模拟植物蒸腾作用的试验装置及方法" (Granted on 30 September 2015)
- Chinese patent publication no. CN103424345A- 吴宏伟、Kamchoom、梁钧和乔劼 "主动控制水在多孔介质中运移方式的系统" (Granted on 22 June 2016).
- UG student, SETIASABDA, Ezra Yoanes, who joined this project (in the development of the SSP sensor) for his final year project, has won the Gold Award, HKUST President's Cup 2014. The project title is "The implementation of Micro-Electro-Mechanical Systems (MEMs) sensors for slope stability monitoring.
- A research collaboration was established with Zhejiang University under the leadership of Professor Yunmin Chen and Tony Liangtong Zhan. They are PIs of a 973 project. A field trial using the new three-layer landfill cover system in a landfill site at Xiaping Shenzhen was agreed upon. Representatives from Zhejiang University (ZU), Harbin Institute of Technology in Shenzhen (HITSZ) and Hohai University (HHU), HKUST and senior management from Xiaping Solid Waste (XSW) company attended the meeting.